

Examining Gender Differences in Mathematics Anxiety among Nigerian Preservice Mathematics, Science, and Technology Teachers

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Abstract

This study examined gender differences in the mathematics anxiety of preservice mathematics, science, and technology (MST) teachers in Nigeria. Using an ex post facto design, data were collected from 2,478 preservice teachers (Males = 1,324; Females = 1,154) at a public university in south-west Nigeria, using the Mathematics Anxiety Scale. A two-way factorial ANOVA showed a significant main effect of gender, $F(1, 2468) = 300.38$, $p < .001$, and a significant main effect of year, $F(4, 2468) = 4.27$, $p = .002$. The gender $\times$ year interaction was not significant, $F(4, 2468) = 1.23$, $p = .294$, showing that the gender gap remained stable across the five years. Independent samples t-tests showed that females recorded significantly higher mathematics anxiety than males across all three MST disciplines. As the study was limited to one university in one geopolitical zone, these findings are not generalisable beyond this context.

Keywords: Gender differences; mathematics anxiety; Nigeria; preservice teachers; mathematics, science, and technology

Introduction

Across the world, more males than females study mathematics, science, and technology (MST) disciplines. This pattern has produced a persistent gender gap in the MST workforce (Master & Meltzoff, 2017). Women in many countries report lower self-confidence and weaker interest in MST than men (Mullis, Martin, & Foy, 2008). They are also less likely to pursue MST careers (OECD, 2015a). Few hold leadership positions in research institutions (OECD, 2015b). Notably, this gap narrows in countries with weaker MST-related stereotypes (Miller, Eagly, & Linn, 2015), this suggests that the gap is shaped by culture, and not ability.

However, the pattern is also evident in Nigeria. Only about 22% to 23.3% of MST

graduates in the country are female (Okafor, 2019). The contributing factors to it include male-dominated cultural norms, a shortage of female role models, gender stereotypes, and mathematics anxiety (Awofala, 2017; Arigbabu & Mji, 2004). Nigerian studies have examined gender differences in mathematics achievement extensively (Awofala, 2017; Arigbabu & Mji, 2004). Far fewer have examined gender differences in mathematics anxiety (Sarfo, García-Santillán, Adusei, Molchanova, Drushlyak, & Semenikhina, 2020; Samson, Abayomi, & Olaitan, 2015). The few results available are mixed (Asikhia, 2021; Adebule, 2004). This gap matters for preservice MST teachers, as their own mathematics anxiety may shape how they later teach the subject. The present study addresses

this gap by examining gender differences in mathematics anxiety among preservice MST teachers in Nigeria over five years (2016–2020).

The cultural stereotypes helped explain this wider gap. Two forms appear repeatedly in the literature, the ability stereotype holds that men are naturally better at MST. The cultural-fit stereotype holds that MST is a masculine domain (Cheryan, Master, & Meltzoff, 2015). Both appear early. Young girls already report less interest and confidence in MST than boys, well before secondary school (Kerger, Martin, & Brunner, 2011). Parents and students alike tend to associate MST with maleness (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2012). MST professionals are often pictured as men (Buck, Plano Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008). These stereotypes may affect how girls see themselves and, in some cases, may make them less willing to consider careers in MST (Farenga & Joyce, 1999).

The influence of such stereotypes is not limited to career choices. They may also affect students' motivation, self-concept, and feelings about mathematics from childhood through university (Cvencek, Meltzoff, & Greenwald, 2011). One of the concerns associated with mathematics is mathematics anxiety, which refers to the feelings of discomfort or fear that some individuals experience when dealing with mathematics. For some students, this may be mild uneasiness, while for others it can result in avoiding mathematics altogether (Ashcraft & Kirk, 2001). Mathematics anxiety has also been associated with difficulties in number processing and working memory (Ashcraft & Kirk, 2001), lower confidence in one's mathematical ability (Jain, 2009), and feelings of tension when working with numbers (Maloney, Ansari, & Fugelsang, 2012). Ashcraft and Krause (2007) estimated that about 17% of the general population experience high levels of mathematics anxiety, while Betz (1978) reported that mild mathematics anxiety may affect about half of university students. In Nigeria, the problem has also received attention, particularly in relation to the social and cultural conditions surrounding women's participation in education and employment. In a society where women may still be viewed mainly in terms of economic dependence, these expectations can influence their experiences with science, technology, and mathematics (Akinsowon & Osisanwo, 2014; Awofala & Akinoso, 2017).

Findings on whether mathematics anxiety differs between males and females, however, have not been consistent. Some studies have reported higher levels of mathematics anxiety among females

(Rahaman, Bornaa, Iddrisu, Suglo, Atepor, & Adams, 2023; Hart & Ganley, 2020). Other studies have found little or no significant difference between the two groups (Brown, Ortiz-Padilla, & Soto-Varela, 2020; Van Mier, Schleepen, & Van den Berg, 2019). There are also studies in which males reported higher levels of anxiety than females (Asikhia, 2021). These differences may be related to variations in the settings in which the studies were conducted, the participants involved, and the methods used to collect and analyse the data (Wilson & Hart, 2001). Another possible explanation is that researchers have not always measured mathematics anxiety in exactly the same way (Birgin, Baloğlu, Çathioğlu, & Gürbüz, 2010). For example, the Mathematics Anxiety Rating Scale developed by Richardson and Suinn (1972) and other measures based on different age groups vary in their length and the aspects of anxiety they assess (Wigfield & Meece, 1988). Thus, a measure that works well with one group of students may not necessarily be appropriate for another. Regardless of these differences, mathematics anxiety remains important because of its relationship with students' mathematics achievement and their continued participation in mathematics-related fields. It is linked to lower mathematics achievement (Barroso, Ganley, McGraw, Geer, Hart, & Daucourt, 2021). It may also help explain why women remain underrepresented in engineering and science careers. This holds true even where women perform as well as, or better than, men (Kenney-Benson, Pomerantz, Ryan, & Patrick, 2006; Rubinsten, Bialik, & Solar, 2012).

Research Questions

1. What are the gender and year differences in preservice MST teachers' mathematics anxiety, and does the gender gap vary from year to year?
2. How do gender differences in mathematics anxiety vary across the mathematics, science, and technology disciplines?

Null Hypotheses

- Ho₁. There is no statistically significant main effect of gender on preservice MST teachers' mathematics anxiety.
- Ho₂. There is no statistically significant main effect of year on preservice MST teachers' mathematics anxiety.
- Ho₃. There is no statistically significant gender × year interaction effect on preservice MST teachers' mathematics anxiety.

Ho₄. There is no statistically significant gender difference in mathematics anxiety of preservice MST teachers across mathematics, science, and technology disciplines.

Methods

Research Design

The present study adopted a quantitative ex post facto design. This design was chosen because gender is a naturally occurring variable. It cannot be manipulated by researchers. An ex post facto design allows comparison of groups that already differ on this variable, without random assignment. This makes it well suited to examining gender differences in mathematics anxiety, since the major goal was to compare existing groups rather than test an intervention. A survey approach was used to collect the data, through the Mathematics Anxiety Scale administered to participants each year.

Participants

The population of senior (400-level) preservice mathematics, science, and technology (MST) teachers was drawn from a large public university in Lagos metropolis. For the years 2016, 2017, 2018, 2019, and 2020, the population was 432,

487, 494, 545, and 520, respectively. Participants were included if they were officially registered as 400-level preservice MST teachers during the relevant academic session. They also had to provide informed consent prior to participation. Students who did not meet these criteria were excluded. Students who declined consent were also excluded. Responses that were incomplete were excluded as well. All eligible senior preservice MST teachers who met these criteria formed the sample. Accordingly, the participants comprised 2,478 senior preservice MST teachers (Males = 1,324; Females = 1,154). They were drawn from one large cosmopolitan public university in Lagos metropolis, Nigeria. Data collection spanned 2016 to 2020, a five-year period. Table 1 shows the gender distribution over this period. The senior preservice MST teachers were further categorised into three groups: science (1,683), technology (278), and mathematics (517) (Table 2). The science group consisted of chemistry (403), biology (690), physics (231), and integrated science (359). The technology group consisted of building/woodwork (130), auto-mechanics (85), and electrical/electronics (63). The ages of the participants ranged from 19 to 32 years.

Table 1 *Distribution of Sample by Year and Gender*

Year	Male N (%)	Female N (%)	Total N (%)
2016	224 (51.9)	208 (48.1)	432 (100)
2017	287 (58.9)	200 (41.1)	487 (100)
2018	257 (52.0)	237 (48.0)	494 (100)
2019	286 (52.5)	259 (47.5)	545 (100)
2020	270 (51.9)	250 (48.1)	520 (100)
Total	1324 (53.4)	1154 (46.6)	2478 (100)

Table 2 *Distribution of Sample by Year and Science, Technology, and Mathematics Groups*

Year	Science N (%)	Technology N (%)	Mathematics N (%)	Total N (%)
2016	307 (71.0)	40 (9.3)	85 (19.7)	432 (100)
2017	322 (66.1)	55 (11.3)	110 (22.6)	487 (100)
2018	339 (68.6)	65 (13.2)	90 (18.2)	494 (100)
2019	365 (67.0)	60 (11.0)	120 (22.0)	545 (100)
2020	350 (67.3)	58 (11.2)	112 (21.5)	520 (100)
Total	1683 (67.9)	278 (11.2)	517 (20.9)	2478 (100)

Research Instrument

One research instrument was used in this study: the Mathematics Anxiety Scale (MAS), which was adopted from Wigfield and Meece (1988). The MAS contains 11 items on a 5-point Likert scale, with responses ranging from Not at all

(1) to Very much (5). The scale has two components: worry and negative affective reaction. It has been validated for Nigerian use, with an internal consistency reliability coefficient of 0.94 as its Cronbach alpha value (Awofala & Odogwu, 2017; Awofala & Akinoso, 2017). Its content validity was

established through expert review of item relevance to the mathematics anxiety construct in these earlier validation studies.

In the present study, internal consistency was recalculated using Cronbach alpha for each year. This was done to check whether the instrument retained its psychometric properties across this five-year period. The reliability coefficients were 0.95 for 2016, 0.92 for 2017, 0.96 for 2018, 0.93 for 2019, and 0.94 for 2020. The reliability coefficients were consistently high across the five years, ranging from 0.92 to 0.96. This indicates that the MAS had good internal consistency throughout the study period and was reliable for use with the participants.

Procedure for Data Collection

The data were collected between 2016 and 2020, with the Mathematics Anxiety Scale (MAS) administered once in each year. The authors administered the instrument with the assistance of postgraduate students who worked as research assistants. Before each exercise, the research assistants were given instructions on the administration of the instrument, including how to introduce the study to the participants, distribute and collect the questionnaires, and respond to questions from the participants. The same procedure was followed each year. The completed questionnaires were collected and retained for analysis. One of the

authors was a member of the university staff, which facilitated access to the Head of the Department of Science and Technology Education for permission to involve the preservice MST teachers in the study. Participants gave their informed consent before completing the MAS in each year of the study. The participants were final-year students in each academic session, and different cohorts were involved across the five years. Confidentiality was observed throughout the exercise, and the identities of the participants were not disclosed.

Data Analysis

The data obtained from the MAS were coded and analysed using SPSS. Incomplete responses were removed before the analysis, so there were no missing scores in the final dataset. Means and standard deviations were calculated to describe the data. A two-way factorial ANOVA was then used to determine whether gender and year had significant effects on the mathematics anxiety of preservice MST teachers and whether there was an interaction between the two factors. Independent-samples t-tests were also conducted to compare the mathematics anxiety scores of male and female participants within the Science, Technology, and Mathematics groups. The analyses were tested at the 0.05 level of significance.

Results

Research Question One: What are the gender and year differences in preservice MST teachers' mathematics anxiety, and does the gender gap vary from year to year?

Table 3a shows the mean mathematics anxiety scores for male and female preservice MST teachers across the five study years. In every year, female preservice teachers recorded higher mean scores than their male counterparts.

Table 3a *Mathematics Anxiety Mean Scores and Standard Deviations by Gender and Year*

Year	Male M	Male SD	Female M	Female SD
2016	26.91	4.66	36.88	7.23
2017	27.26	5.04	38.82	6.30
2018	27.47	5.39	38.19	6.65
2019	28.30	5.92	39.02	6.00
2020	28.11	6.02	38.30	6.45

Note. M = mean; SD = standard deviation.

A two-way factorial ANOVA was conducted to test the main effects of gender and year, and their interaction, on mathematics anxiety (Table 3b). Gender had a statistically significant main effect on mathematics anxiety, $F(1, 2468) = 300.38$, $p < .001$, partial $\eta^2 = .109$, a medium-to-large effect. Female preservice MST teachers reported significantly higher mathematics anxiety than males overall. H_{01} is therefore rejected. Year also had a statistically significant main effect, $F(4, 2468) =$

4.27 , $p = .002$, partial $\eta^2 = .007$, a small effect, indicating that mathematics anxiety levels varied modestly across the five years, independent of gender. H_{02} is therefore rejected. The Gender $\times$ Year interaction was not statistically significant, $F(4, 2468) = 1.23$, $p = .294$, partial $\eta^2 = .002$, indicating that the gender gap in mathematics anxiety remained stable across the five-year period. H_{03} is therefore not rejected.



Table 3b *Two-Way Factorial Analysis of Variance for Mathematics Anxiety by Gender and Year*

Source	df	F	p	Partial η^2
Gender	1	300.38	< .001	.109
Year	4	4.27	.002	.007
Gender $\times$ Year	4	1.23	.294	.002
Error	2468	—	—	—

Note. Partial η^2 = partial eta squared.

Research Question Two: How do gender differences in mathematics anxiety vary across the mathematics, science, and technology disciplines?

Table 4 presents the mean scores, standard deviations, t-values, and effect sizes for male and female preservice teachers in the Science, Technology, and Mathematics groups across the five years. Independent-samples t-tests were used to determine whether the mathematics anxiety scores of male and female participants differed within each group.

The results show that female preservice teachers had higher mathematics anxiety scores than

their male counterparts in all three groups throughout the five years. The differences were statistically significant in every comparison, with t-values ranging from 5.97 to 23.48 and $p < .001$. The effect sizes were also substantial, ranging from 1.14 to 6.03. The largest difference was recorded in the Technology group in 2019, where Cohen's d was 6.03. Based on these results, H_{04} was rejected. The same pattern across the Science, Technology, and Mathematics groups indicates that the observed gender difference was not limited to one particular discipline. Female preservice teachers consistently reported higher mathematics anxiety across the MST groups examined in the study.

Table 4 *Mathematics Anxiety Mean Scores, Standard Deviations, t-Values, and Effect Sizes for Science, Technology, and Mathematics Groups*

Year	Group	Male M	Male SD	Female M	Female SD	t	p	Cohen's d
2016	Science	27.55	4.66	35.49	7.76	10.96*	.00	1.24
	Technology	26.10	4.79	41.00	3.67	10.95*	.00	3.49
	Mathematics	24.98	4.06	40.00	4.30	16.58*	.00	3.59
2017	Science	27.49	4.64	37.32	6.82	15.39*	.00	1.69
	Technology	23.81	3.28	41.09	4.43	16.64*	.00	4.43
	Mathematics	28.28	6.11	42.07	3.33	13.78*	.00	2.80
2018	Science	27.36	4.67	36.64	7.10	14.31*	.00	1.54
	Technology	26.56	4.42	41.52	3.98	14.28*	.00	3.56
	Mathematics	28.57	7.91	41.70	3.58	9.98*	.00	2.14
2019	Science	27.51	4.66	38.08	6.54	17.91*	.00	1.86
	Technology	23.42	2.62	41.90	3.45	23.48*	.00	6.03
	Mathematics	33.11	7.32	40.24	4.71	6.61*	.00	1.16
2020	Science	27.36	4.67	37.20	6.82	15.85*	.00	1.68
	Technology	26.03	4.38	41.89	3.31	15.46*	.00	4.09
	Mathematics	31.55	8.71	39.83	5.49	5.97*	.00	1.14

Note. * $p < .05$

Discussion

The study examined gender differences in mathematics anxiety among senior preservice MST teachers over the five-year period from 2016 to 2020. The results showed a clear difference between the male and female participants. Female preservice teachers reported higher levels of mathematics

anxiety than males, both in the overall results and across the three MST groups. Year was also found to have a significant effect, although the effect was small. However, the interaction between gender and year was not significant. In other words, the difference between male and female participants was fairly similar across the five years; it did not show

any clear increase or decrease over time. The same trend was observed when the participants were considered according to their discipline. In Science, Technology, and Mathematics, the female participants had higher mathematics anxiety scores than the males in each of the five years. This shows that the difference was not peculiar to one of the three areas considered in the study. Rather, the results point to a similar pattern among the female preservice teachers across the MST groups included in the study.

There are, however, some limitations to the interpretation of these findings. The study focused mainly on gender differences in mathematics anxiety, both for the participants as a whole and within the three discipline groups. It did not examine the interaction between gender and discipline because the data were not organised in a way that allowed this type of analysis. In addition, the participants were drawn from only one university in Lagos, south-west Nigeria. The findings should therefore be considered within this particular setting. The relatively similar number of male and female participants in the MST programmes may also reflect the social and educational conditions in the region. This may not necessarily be the case in other parts of Nigeria, where girls' educational experiences can be different. For this reason, the findings should not be taken as representing preservice MST teachers across the whole country.

These findings are broadly consistent with prior research. Many studies have similarly found that females report higher mathematics anxiety than males (Rahaman, Bornaa, Iddrisu, Suglo, Atepor, & Adams, 2023; Else-Quest, Hyde, & Linn, 2010). Other studies have reported no gender difference (Van Mier, Schleepen, & Van den Berg, 2019). Such contradictions are not unusual in gender-related research. Studies differ in learning context, classroom setting, geography, and methodology (Wilson & Hart, 2001; Arigbabu & Mji, 2004). This may explain some of the inconsistency across the wider literature, even where the present study's own findings are clear.

Interestingly, this study also found parity in MST enrolment between males and females. This runs counter to the wider stereotype of MST as a male-dominated field (Master & Meltzoff, 2017). Even so, a clear gender gap in mathematics anxiety persisted. Several factors may help explain this. Sociocultural pressures, including stereotype threat, cultural expectations, and a shortage of female role models, may heighten mathematics anxiety among female preservice teachers (Awofala & Anyikwa, 2014; Arigbabu & Mji, 2004). Females are often

socialised to view MST as outside typically "feminine" pursuits. This belief ordinarily, may itself fuel anxiety around mathematics.

Psychological factors may also play a role. Lower self-efficacy, fear of failure, and perfectionism have each been linked to elevated mathematics anxiety (OECD, 2019). A persistent fear of failing in mathematics may compound this effect. Perfectionistic tendencies may simultaneously raise anxiety and undermine motivation (Awofala, Lawani, & Adeyemi, 2020). Parental and familial influences may contribute as well, including parental expectations, family attitudes, and the degree of parental involvement (García-Mendoza, Parra, Sánchez-Queija, Oliveira, & Coimbra, 2022). Negative attitudes expressed within the family may reinforce or activate anxiety around the subject. These sociocultural and psychological explanations remain more directly supported by the present data than untested biological accounts, which fall outside the scope of this study.

Conclusion

This study examined gender differences in the mathematics anxiety of senior preservice MST teachers in Nigeria over a five-year period. The study found that female preservice MST teachers had higher mathematics anxiety than their male counterparts. This difference was seen in the overall results and across the Science, Technology, and Mathematics groups. The difference between the two genders also remained fairly steady from 2016 to 2020, with no significant change over the five-year period. The findings therefore show that gender differences in mathematics anxiety were present across the different years and MST groups examined in this study.

However, the study was carried out in only one university in south-west Nigeria. The findings are therefore limited to the setting and participants involved in the study and should be interpreted with this in mind. They cannot be taken to represent the situation among preservice MST teachers in all parts of Nigeria.

Recommendation

Based on the findings of the study, the following recommendations are made:

1. Teacher education programmes should provide support that can help female preservice MST teachers manage and reduce mathematics anxiety.
2. Similar studies should be carried out in universities across the other geopolitical

zones of Nigeria. This would help to determine whether the gender difference found in this study is also present in other parts of the country.

3. Future researchers should keep records that clearly show the participants' gender, discipline, and year of study. This would make it possible to examine how these factors relate to one another in greater detail.
4. Universities should consider providing support for students who show signs of mathematics anxiety from the beginning of their MST programmes, rather than waiting until the final year. The present findings suggest that the difference in anxiety between male and female students was already evident among the final-year students.

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